Stability Improvement Area[1,2]	Unit[10]	WEST SEATTLE										MAGNOLIA/QUEEN ANNE									MADRONA						
		23rd Avenue S.W.	Admiral Way	Fairmount Gulch	Harbor Avenue	Alki Avenue	Boyd/Chilberg Place	Jacobsen Road	Beach Drive/Atlas Place	47th Avenue S.W.	Seola Beach	Perkins Lane North	Perkins Lane South	32nd Avenue W.	W. Galer Street	Magnolia Way	Kinnear Park	West Queen Anne	Northwest Queen Anne	East Queen Anne	Hillside Drive	32nd Avenue E.	Madrona Drive	Madrona Park	Lake Dell	Lakeside North	Lakeside South
Number of Landslides																											
High Bluff Peeloff												11	7	3	2		1										
Groundwater Blowout					5	7		1		1		4			1	1	2	4			1						
Deep-seated		10	9		8	11	4	6	6	1	2	40	6		1		2	7	7	1	2	3	3		2	3	6
Shallow Colluvial		6	17	10	48	86	3	11	19	19	4	56	4	5	6	9	7	12	7	19	2	3	5	6	14	5	10
Unidentified		8		1		2																					1
Total		24	26	11	61	106	7	18	25	21	6	111	17	8	10	10	12	23	14	20	5	6	8	6	16	8	17
Subsurface Conditions [3]																											
Colluvium Over Glacially Overridden Clay		X										X								X			X			X	X
Colluvium Over Glacially Overridden Sand and Gravel											X																	
Colluvium Over Glacially Overridden Sand-Clay			X	X	X	X	X	X	X			X							X		X	X	X	X	X		
Colluvium Over Glacially Overridden Till-Sand-Clay										X		X			X	X	X										
Colluvium Over Glacially Overridden Till-Clay													X	X				X									
Sand-Clay Contact (Tubbs, 1974) Mapped in Area			X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			X		X	X		
Contributing Causes of Instability																											
Steep Topography			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X			X		X		
Loose Fill or Colluvium on Slope				X		X	X	X	X		X	X	X	X			X	X			X	X					
Colluvium Over Clay		X	X		X							X	X							X						X	
High Groundwater Levels (Seepage and Springs)		X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Road Cuts and Fills (Public)			X			X	X	X	X	X					X			X	X	X		X	X	X	X	X	X	X
Undercutting and Filling (Private)		X	X		X	X	X	X	X	X	X						X	X	X	X		X		X	X		
Improperly Directed Surface Water			X						X						X	X		X		X	X				X	X		
Heavy Rainfall with Surface Runoff (Trigger Mechanism)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X	X			
Stability Improvements																											
Homeowner Education		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Strom Drain Maintenance/Improvement (Curbs/Gutters/Catchbasins)		X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X		X	X	X	X	X
Trench Subdrains (10 ft deep)	LF							1,100	1,400						350												
Trench Subdrains (15 ft deep w/ trenchbox)	LF		1,100		1,500	1,600		900										850		800							
Finger Drains	EA	10	5									12									5			5			4
Springhead Drains	EA			5	5	5			5			6		8-10	7			5			5			5	10		3
Mechanically Stabilized Earth Wall [4, 8]	SF																6,250										
Geotextile Reinforced Soil Slope [5]	SF																6,250										
Combined Flattened Slope and Interceptor Trench [6]	LF																250										
Slope Grading (Excavation)	CY																										
Machine Formed Curbs	LF							1,600	3,800	1,200						1,300							500				
Retaining/Catchment Wall (10 ft high)	SF		23,000		20,000	36,000			9,000	8,000		7,000					7,000			25,000		2,000			12,000	3,250	6,500
Fill Stabilization-Excavation and Replacement (20 ft wide, 7 ft deep) [7]	CY				2,100				2,900												2,600						
Excavation	CY				2,100				2,900												2,600						
Soil Backfill and Compaction	CY				2,100				2,900												2,600						
Asphalt Paving	SY				900				1,250												1,100						
Machine Formed Concrete Curbs	LF				400				560												500						
Drainage Improvements [9]																											

General Note:

The Stability Improvements presented here are general types of measures that could be considered by the City, private property owners, or both, to improve stability. The number, length, square footage, etc., listed are very rough estimates of work on City and/or private properties presented only as a basis to formulate order-of-magnitude budgets.

Notes:

1. This table should be used in conjunction with the text describing each Stability Improvement Area, and with the cost data presented in Table 2-1.

2. The stability improvements listed here are preliminary and are presented to provide the city and private property owners with data for use in prioritizing work and developing order-of-magnitude budgets. Final scopes of work and corresponding cost estimates should be based on additional engineering studies and subsurface explorations.

3. Subsurface conditions may vary within a particular Stability Improvement Area. Many sites contain fill material on a slope or at the top of the slope.

4. Option 1 (Kinnear Park): Estimated cost for Mechanically Stabilized Earth (MSE) Wall (250 feet long, 25 feet high) is $350,000.

5. Option 2 (Kinnear Park): Estimated cost for Geotextile-Reinforced Soil Slope (250 feet long, 25 feet vertical height) is $244,000.

6. Option 3 (Kinnear Park): Estimated cost for Combined Flattened Slope and Interceptor Trench (25 feet deep) is $215,000.

7. Includes excavation of listed volume of material (CY), replacement soil backfill and compaction, installation of drainage improvements (if necessary), asphalt paving, and installation of machine formed concrete curbs. See individual costs for each of these items, as deemed necessary.

8. Standard MSE wall for other than Kinnear Park.

9. If necessary, type and quantity will depend upon site conditions.

10. CY = cubic yard, EA = each, LF = lineal foot, SF = square foot, SY = square yard

Seattle Landslide Study
Seattle Public Utilities
Seattle, Washington

STABILITY IMPROVEMENT AREAS
WEST SEATTLE,
MAGNOLIA/QUEEN ANNE, MADRONA

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SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

TABLE 3-1